DOCUMENT RESUME

ED 276 242 EC 191 360

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TITLE Making Apple Computers Accessible to Blind Children.
PUB DATE 86
NOTE 11p.; In: Murphy, Harry J., Ed.; Dunnigan, J. A., Ed. Computer Technology and Persons with Disabilities: Proceedings of the Conference (Northridge, California, October 17-19, 1985); see EC 191 351.
PUB TYPE Speeches/Conference Papers (150) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Accessibility (for Disabled); *Blindness; *Communication Aids (for Disabled); *Computer Software; Elementary Education; *Microcomputers; *Visual Impairments
IDENTIFIERS Apple II; *Speech Synthesizers

ABSTRACT

The study examined the feasibility of adapting commercially available educational software to a speech synthesizer compatible with the Apple II for use with 15 visually impaired students 8 to 12 years old. Ss were pre-tested on measures of auditory discrimination, computer literacy, keyboard proficiency, spelling, and language. Ss then received tutoring with the Echotype program (a typing program); 10 Ss received instruction with the Spelling Program; and 5 with the Language Program. Findings suggested increased exposure to the voice synthesizer was necessary to help students become sufficiently accustomed to the speech. All Ss showed considerable improvement in the typing skills, while the spelling program appeared to be enjoyable and motivating. Ss' anxiety about computers decreased while their feelings of efficacy in using a computer increased slightly. (CL)

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Making Apple Computers Accessible To Blind Children

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Introduction

Today's children are learning through Computer Assisted Instruction (CAI) and gaining computer literacy as early as the pre-school age. There are an estimated 200,000 computers in educational settings throughout the United States with 600,000 expected by 1985 (Market Data Retrieval, 1983). While many children are preparing for success in our computer world, visually impaired children have been denied the experience of CAI as well as other opportunities to gain computer literacy. If continued, this lack of experience will widen the gap between these students and their sighted counterparts, needlessly compounding the disability.

In 1983, a review of the literature showed the Apple computer had been made to "talk" for a limited amount of software. However, this work was limited to use by visually impaired professionals and college students rather than visually impaired school children. Even the voice4 synthesizer peripherals presently available for Apple computers are of limited use because the lack of compatible software. It was because of these concerns that Sensory Aids Foundation (SAF) undertook the present project. We set out to test the feasibility of adapting off-the-shelf educational software to a speech synthesizer unit that was compatible with the Apple II personal computer and would be within the financial reach of most school districts. The project was to make any necessary adaptations to selected software and then test the efficacy of the speech synthesizer and adapted software in teaching children specific skills. The project was to also investigate the motivational effects of CAI on the participating children, as well as, the effects on their feelings about computers and computer use in

general.

Methods

Subjects

Subjects for the project were 15 visually impaired students recruited from the San Francisco Bay Area. The students had varying degrees of visual impairment but no other disabilities. There were 8 female and 7 male subjects with an age range of 8-12 years old.

Materials

Subjects were administered a battery of pre- and post-tests. These included the Wepman Auditory Discrimination Test with the synthesizer speaking the words, a shortened version of the Minnesota Computer Literacy Questionnaire (Anderson, Johnson, Hansen, and Klassen, 1979), a standard typing test (4th grade level), and the Stanford Achievement Tests (Primary Levels II and III, Form A (4-2440 and 6-2234) by Richard Madden, Eric H. Gardner, Herbert C. Rudman, Byron Karlsen and Jack C. Merwin) for spelling and language (given at the appropriate grade-level for each child).

The Apple II computer was selected for the study because of the large number of existing units in the local school systems. Market Data Retrieval, 1983, reported an estimated 200,000 computers in educational settings throughout the United States with 600,000 expected by 1985. The speech synthesizer used was the Echo II by Street Electronics. After reviewing the available speech synthesizers, the Echo II was chosen for its compatibility with the Apple II, ease of use, and relatively low cost.

Three different educational software packages were tested. These

included Echotype, a typing program developed by Sensory Aids Foundation from Mastertype by Scarborough Systems, The Spelling Program and The Language Program, the latter two developed solely by SAF.

Procedures

Subjects were administered the pretests for auditory discrimination, computer literacy, keyboard proficiency, spelling and language. Subjects then received tutoring with an Apple II computer for 30-45 minutes each week for as many as 15 weeks. All 15 subjects received instruction with the Echotype program, 10 subjects received instruction with The Spelling Program, and 5 received instruction with The Language Program. At the end of the instruction period, post-tests were administered.

Assessment

Because of the small number of subjects and the exploratory nature of the present study, statistical analysis of data would not have been fruitful. Thus, each case was looked at individually with the goal of identifying possible trends and suggesting further research questions.

Results and Discussion

Because of the method of assessment and the nature of the results, the Results and Discussion sections are combined so as to present the material more clearly. Thus, the project will be broken down by component and each will be assessed and discussed.

Efficacy of Speech Synthesizer

One of the concerns of the project was that the selected speech synthesizer, although possessing other desirable attributes, would not

produce sufficiently clear speech to be useful to students. This would be especially problematic with software such as the Echotype program which requires students to accurately identify single words, as opposed to words in a sentence which can then be understood by using sentence structure and context as guides. These concerns were borne out by the results of the Wepman pretest. When identifying two words as the same, subjects were correct an average of 93% of the time. However, when the two words were different, subjects responded correctly an average of only 44% of the time. These scores were clearly due to the synthesizer's lack of fidelity which made distinguishing similar sounding words extremely difficult. We hypothesized that with repeated exposure to the mechanical sounding speech produced by the synthesizer. This, in fact, proved to be the case. In the Wepman post-test, subjects averaged 97% correct responses to the same-word pairs, and 56% correct responses to the different word pairs. These results were obtained with a maximum exposure to the speech synthesizer of 45 minutes per week. This limited exposure constrained the extent to which subjects could become adjusted to the synthesized speech. The experience of the two researchers who conducted the CAI, and thus, had more exposure to the synthesized speech, was that with increased exposure one becomes sufficiently accustomed to the speech. This is supported by the Wepman post-test results, although the extent to which subjects would adjust still needs to be more exactly determined. The difficulty of unclear speech can also be compensated for by adjustments in the actual software, which would change the incorrect pronunciation of words not consistent with the phonetic rules used in programming the synthesizer.

Software

An original goal of the study was to take off-the-shelf educational software and use it, with little or no adaptation, with the Echo II. However, early in the study it became apparent that, almost without exception, educational software is very graphics oriented, much of it to the extent that a "video game" format is followed. This dependence on graphics to convey educational content, while perhaps motivating for sighed children, makes the software unsuitable for adaptation to a voice synthesizer. The only software for which this was not the case was older public domain educational software. This was judged inadequate in terms of instructional content. Consequently, releases from the copyright holders of one piece of software (Mastertype by Scarborough Systems) were obtained so changes could be made. The remaining two programs were developed by SAF.

Most software on the market today is protected so that a programmer may not enter the program in order to "look" at how it was written without knowing the entry code for the particular piece. The negotiation time needed to obtain permission from the software publishers to make the necessary adaptations is often six months or more. It therefore, would be useful if writers of educational software could make available to special educators unprotected copies of their software.

Echotype

Not only are keyboard skills necessary to use a computer for someone with a visual impairment, they are usually an important aspect of that person's education as typing facilities his or her ability to complete schoolwork. Using Mastertype as a model, SAF developed the

Echotype typing program. As determined by the typing pre- and post-tests, all of the subjects showed considerable improvement in their typing skills. All the subjects learned the letters on the keyboard and all increased their typing speeds. One subject improved from not knowing any keys on the keyboard to typing 19 words per minute. Many subjects commented on how motivating it was to work on a computer. These improvements were seen with subjects receiving only one 30 minute session of CAI per week. Thus, the Echotype program appears to be an effective method for teaching typing skills to visually impaired students and additional sessions per week would increase this efficacy.

The Spelling Program

The Spelling Program was developed by SAF. The overall effectiveness of this program was difficult to assess due to its use by only 10 of the students and the small incremental difference in the spelling pre- and post-test scores. Anecdotal evidence indicates that this was a program that the students enjoyed and felt motivated to use. This program was the subjects favorite because they were able to enter their own word lists. As one subject put. "I like this one the best because I am programming it."

The Language Program

Due to a longer than anticipated development time, this program was tested with only 5 of the students. There was little increase from the language pre- to post-test scores, this being explained, at least partially, by the short amount of time subjects spent with this program. However, teachers found this program to be their favorite since they could enter any multiple choice questions for the students to

practice.

Computer Attitude

One goal of the subject was to ascertain the effect of CAI on the computer-related attitudes of visually impaired students. This was done by using a shortened version of the Minnesota Computer Literacy Questionnaire. The questionnaire looked at five dimensions: Enjoyment, Anxiety, Efficacy, and Sex-typing. Each dimension was rated on a scale of 5-25. The results of the pre- and post-tests contained some expected and some unexpected figures (see Table 1).

	enjoy	anxiety	efficacy	sex
pre-	24.0	10.0	17.6	14.0
post-	22.6	7.9	17.9	19.3

Scores averaged across subjects.

Table 1

The first surprise was that enjoyment scores actually went down, although they still remained extremely high. This might be an indication that the original scores were inflated due to unrealistic expectations about computers. The second was that the sex-type score increased, which indicates a drop in sex-typing for computer use. This was surprising in that the synthesized speech product by the Echo II is rather masculine sounding. This was apparent to the researchers as well as to the subjects who remarked upon the fact a number of time. A closer look at the scores indicated that the change was due primarily to the female subject who showed a proportionately greater increase than the males in their post- versus pre-test scores.

The other scores show that with computer experience subjects' anxiety about computers decreased, while their feelings of efficacy in

using a computer went up, albeit slightly. Apparently, the decrease in the enjoyment scores, perhaps due to unreasonable expectations, did not seem to have a detrimental effect on the degree of anxiety students felt about computers nor on their feelings of efficacy.

General Comments

The difficulties inherent to presenting statistical results to support a study such as this one are twofold. First, no matter what the results, they are statistically meaningless. Second, statistics inevitable fail to capture all of what occurred during such a project and thus provide only a partial description. What the numbers fail to convey are the reactions of the students and their Special Education teachers to the CAI. These reactions were consistently ones of enthusiasm, with students often being motivated to do work (such as typing lessons) on the computer that they would not do in the classroom. Among our students, motivation ran extremely high and this, according to their teachers, was directly attributable to the CAI. Students frequently cited reasons such as "Now I'm doing what the other kids do." or even "Now I'm doing things that the other kids aren't yet." as to why they found the CAI so motivating. It should be stressed that this was despite the prototypical nature of the software being used, which meant that it was not as sophisticated, and therefore as stimulating, as most of the present educational software for sighted children.

Conclusion

As a result of this project, 15 visually impaired students in the San Francisco Bay Area had the same opportunity as their sighted peers

to use a computer. Our society is moving with increasing speed into the computer age and with the aid of projects like the present one, those of us with a visual impairment will be able to share in the new technology. Early exposure to computers is an important factor in motivating children to do further work with computers and to consider computer related careers. For the visually impaired or blind child this also means another opportunity to participate in mainstream society.

As one student in the 4th grade said, "I feel more a part of the kids in my regular classroom because I can do the same stuff they can with a computer using the voice synthesizer."

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